Experimental detectability of spin current shot noise

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A spin current crossing a ferromagnet-metal interface is accompanied by spin current shot noise, which is well understood in spin space [1]. In experiments, however, the direct detection of pure spin properties is challenging. Therefore, spin currents are typically converted to charge currents via the spin Hall effect. Here, we analyze the challenges of detecting spin current shot noise in the charge channel from an experimental perspective. In detail, we show that in a typical electrically detected spin pumping experiment, the voltage noise originating from the spin current shot noise is orders of magnitude smaller compared to the contribution of the charge-based Johnson-Nyquist noise. We quantify the ratio between spin current shot noise and Johnson-Nyquist noise (both in the charge channel). Notably, this ratio does not scale favorably with geometry and only depends on intrinsic material parameters. Our results suggest that the detection of spin current shot noise in the charge channel via the spin Hall effect as conversion mechanism is very demanding if not impossible.

References:

[1] A. Kamra and W. Belzig, *Phys. Rev. Lett.* **116**, 146601 (2016).